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U. S. NAVAL PROVING GROUND
DANEGREN, VIRGINIA

REPORT NO. 1067

TEST AND DEVELOPMENT OF 3"/70 AA PROJECTILES

491436 Partial Report

TEST OF 3"/70 AA PROJECTILES
WITH RUSTY FORWARD BAND
FIRED IN GUN TYPE B MOD 5 NO. 24480

FINAL Report

101

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Test of 3"/70 AA Projectiles with Rusty Forward Band
Fired in Gun Type B Mod 5 No. 24430

The tests upon which this report is based were conducted by:

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By direction

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Test of 3"/70 AA Projectiles with Rusty Forward Band
Fired in Gun Type B Mod 5 No. 24480

polished surface. The enlarged dark spots are iron oxide embedded in the surface. These spots could not be removed by swabbing with cotton saturated with water or alcohol.

PART D

CONCLUSIONS

9. It is concluded that 3"/70 AA projectiles Type EX 24 Mod 9 will lose an unacceptable number of their mild steel forward centering bands in flight if the bands are corroded to the extent of having a .005 layer of iron oxide. Iron oxide particles collected from the forward band of a projectile exposed to a salt fog spray for seven days will score polished gun steel of hardness 30 Rc.

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Test of 3"/70 AA Projectiles with Rusty Forward Band
Fired in Gun Type B Mod 5 No. 24480

rubbed by hand, with medium pressure exerted, over a polished section of a gun barrel. The barrel section had a hardness value of 30 Rc. A photomicrograph was made of the polished surface before and after the abrasion test (Figure 17).

The remaining eight (8) projectiles were prepared for recovery firing at service charge from the 3"/70 gun Type B Mod 5, Serial No. 24480. All projectiles were epsom salt loaded to a weight of 15 pounds, fitted with dummy nose plugs (Figure 18), and rubber crimped in EX-3 steel cases.

Microflash pictures were taken 155 feet from the muzzle (Figures 13-16, inclusive). Star gauge data taken in the gun barrel before and after this firing program are included as Tables II and III, Appendix (C).

8. RESULTS AND DISCUSSION:

Photographs of the projectiles before and after exposure to the salt fog spray in the corrosion test chamber are included as Figures 1-4, inclusive. Iron oxide rust approximately 0.005 thick formed on the forward bands.

Complete before and after firing data on the eight (8) projectiles fired are given in Table I, Appendix (A). Photographs of the projectiles after recovery are included as Figures 5-12, inclusive. The projectiles were all without forward bands on recovery. The number of projectiles that retained their forward bands in flight could not be determined as microflash pictures were obtained on only four of the eight rounds. Two of the four projectiles successfully photographed in flight had lost their forward bands (Figures 14 and 16). Reference (c) reported that all EX 24-9 projectiles fired in a previous test retained their bands in flight. The flight pattern, as determined by a yaw card 550 feet from the muzzle, shows considerable dispersion and yaw on most of the rounds fired, as could be expected of this gun in its state of wear.

Photomicrographs of a polished section of a gun barrel (hardness value 30 Rc), rubbed with rust collected from a corroded band, are included as Figure 17. Figure 17(A) shows the polished surface with small particles of impurities before the abrasion test. Figure 17(B) shows distinct scratches or grooves caused by the abrasiveness of the iron oxide filings in contact with the

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Test of 3"/70 AA Projectiles with Rusty Forward Band
Fired in Gun Type B Mod 5 No. 24480

PART C

DETAILS OF TEST

6. DESCRIPTION OF ITEM UNDER TEST:

a. Projectile: The 3"/70 AA projectiles Type EX 24 Mod 9 used in this test were manufactured in accordance with reference (b). The EX 24 Mod 9 projectiles have a mild steel (carbon content 0.12 maximum, suitable for deep drawing) forward centering band pressed to shape on the body of the projectile (See Figure 1).

b. Gun: 3"/70 gun barrel Type B Mod 5 No. 24480 with a 1 in 20 caliber twist and disappearing rifling. The gun selected was in a badly worn condition, having been fired 761 equivalent service rounds.

7. PROCEDURE:

Ten (10) 3"/70 AA projectiles Type EX 24 Mod 9 were used in this test. The protective coating was removed from the forward band of each projectile. Six (6) of the above projectiles had three (3) 3/64" holes drilled (approximately 120° apart) through the forward band. All exposed areas of the bodies were retouched with black paint to prevent rust from forming thereon. The projectiles were placed in the salt fog corrosion test chamber for a period of three (3) days. The projectiles were removed from the chamber because the protective coating failed to prevent body rust. After wiping the remaining protective coating and paint from the projectiles (Figure 2), they were coated with Cyclon plastic coating and again placed in the spray chamber. After four (4) additional days exposure to the salt spray, it was believed sufficient corrosion had formed on the forward bands of the projectiles to warrant their removal from the chamber (Figure 3).

Iron oxide rust approximately 9000 thick had formed on the forward bands. The bands of two (2) of the projectiles (one with holes drilled, one without) were removed for inspection of the underside of the band and the band seat (Figure 4). A portion of the rust was removed from one of these bands and collected. The rust particles were then placed on a piece of damp cotton and

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Test of 3"/70 AA Projectiles with Rusty Forward Band
Fired in Gun Type B Mod 5 Mo. 24480

PART B

INTRODUCTION

1. AUTHORITY:

This program was authorized by reference (a).

2. REFERENCES:

- a. FoneCon All/3203-1 OTE-1:RBB:ms between BUORD
(Mr. M. A. Sheppa, Re3b) and NAVPROV (Mr. R. B. Butler)
of 29 Feb 1952
- b. BUORD Sk. No. 328486 (3"/70 AA Projectile Type EX 24
Mod 9)
- c. NPG Report No. 970 of 7 May 1952 = 328486

3. BACKGROUND:

In furtherance of the copper conservation program, the use of collapsing centering bands of mild steel as forward bands on 3"/70 AA projectiles is being considered. When new or coated with a protective material, these steel bands perform satisfactorily with no apparent detrimental effect on projectile ballistics. The standard gilding-metal band is engraved when fired, while the steel band is forced down flush with the projectile body. However, the value of the steel band is questionable owing to the susceptibility of steel to corrosion in its exposure to various climatic conditions.

4. OBJECT OF TEST:

The object of this test was to determine the effect of rust on the forward band of the 3"/70 AA projectile EX 24 Mod 9 and to obtain data on the amount of rusting required to cause band failure.

5. PERIOD OF TEST:

- | | |
|------------------------------------|------------------|
| a. Date of Telephone Authorization | 29 February 1952 |
| b. Date Test Commenced | 6 March 1952 |
| c. Date Test Completed | 18 April 1952 |

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Test of 3"/70 AA Projectiles with Rusty Forward Band
Fired in Gun Type B Mod 5 No. 24480

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Test of 3"/70 AA Projectiles with Rusty Forward Band
Fired in Gun Type B Mod 5 No. 24480

PART A

SYNOPSIS

1. Ten (10) 3"/70 AA projectiles Type EX 24 Mod 9 were subjected to a salt fog spray in a special corrosion test chamber to induce corrosion of the mild steel forward centering band. Two (2) of the forward bands were removed for inspection of the underside of the band and the band seat. The remaining eight (8) projectiles were fired in a worn gun to test the effect of the corroded band and to determine the amount of rusting required to cause band failure.
2. It is concluded that 3"/70 AA projectiles Type EX 24 Mod 9 will lose an unacceptable number of forward bands in flight if the bands are corroded to the extent of having a 7005 layer of iron oxide. Iron oxide filings collected from the forward band of a projectile exposed to a salt fog spray for seven days will score polished gun steel of hardness 30 Rc.

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Test and Development of 3"/70 AA Projectiles

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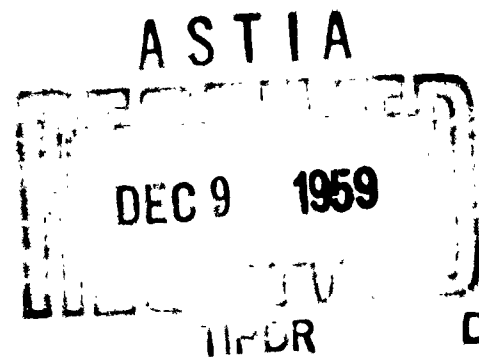
Final Report

on

Test of 3"/70 AA Projectiles with Rusty Forward Band

Fired in Gun Type B Mod 5 No. 24480

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Test of 3"/70 AA Projectiles with Rusty Forward Band
Fired in Gun Type B Mod 5 No. 24480

TABLE I

COMPLETE BEFORE AND AFTER FIRING DATA

Test of 3"/70 AA Projectiles Type EX 24-9 with
Rusty Forward Band in Gun Type B Mod 5 No. 24480

<u>Proj. No.</u>	<u>Firing Order</u> 4/18/52	<u>Powder Charge (lbs.)</u> SPDN-3531	<u>Avg. Pressure (tsi)</u>	<u>Muzzle Velocity (ft./sec.)</u>	<u>Forward Band See Note</u>	<u>Yaw</u>
1224	1	8.9	18.6	3375	A	Consid- erable
1225	2	8.9	18.5	3404	A	Consid- erable
1226	4	8.9	17.7	3346	A	None
1227	6	8.9	17.9	3366	A	Slight
1228	8	8.9	18.8	3338	A	None
1229	3	8.9	18.9	3359	--	None
1230	5	8.9	19.0	3342	--	None
1231	7	8.9	18.4	3331	--	Slight

Gun Type B Mod 5 had 761 ESR at start of test.

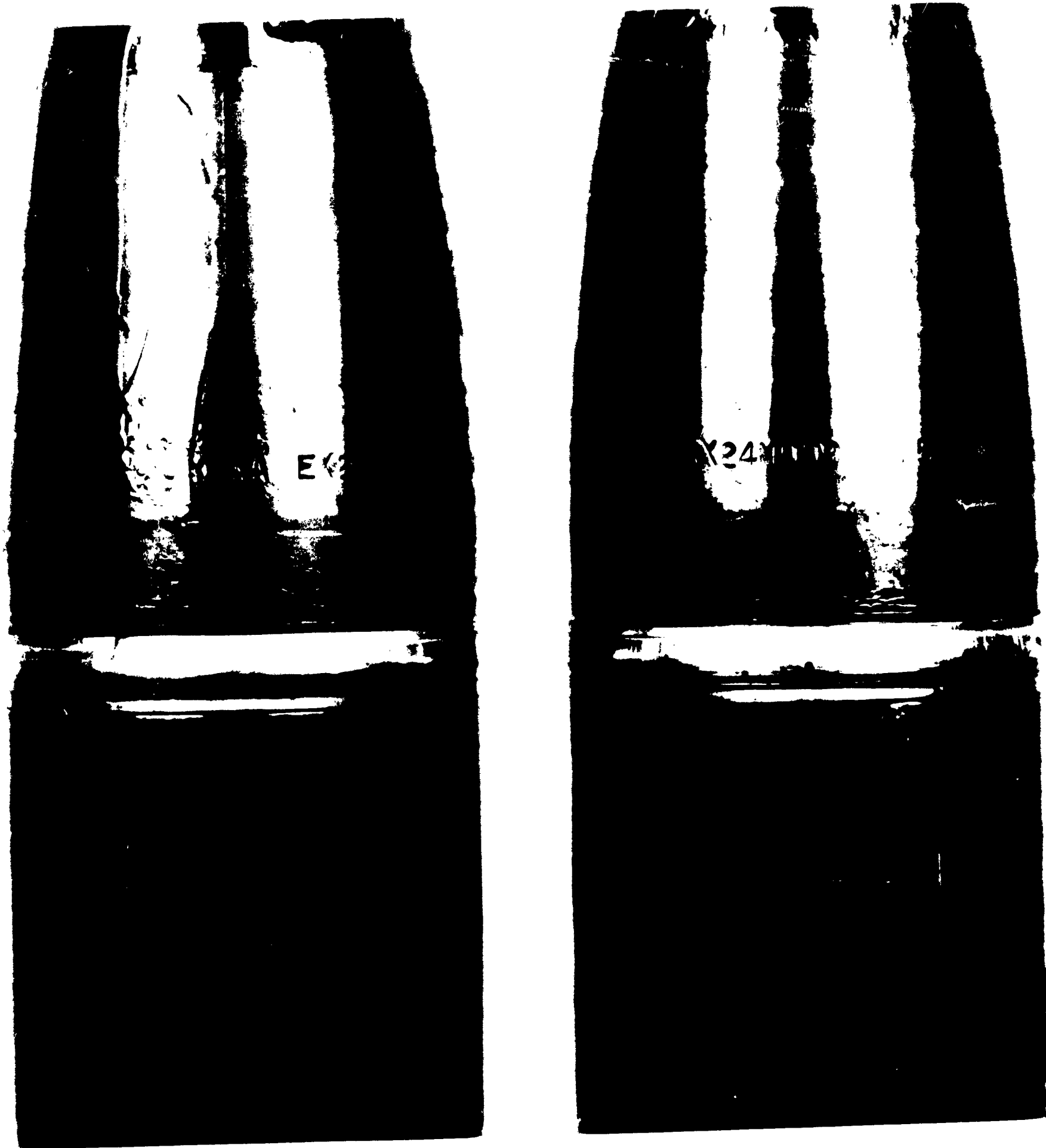
All forward bands were off after recovery.

Microflash Pictures show projectiles 1224 and 1227 retaining band.

Note A: Projectiles had 3-3/64" diameter holes drilled in forward band.

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APPENDIX A



NP9-50922

8 March 1952

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Forward bands of 3"/70 AA projectiles Type EX 24 Mod 9 prior to salt fog spray exposure. The projectile on the right had 3-3/64" holes drilled through band.

Figure 1



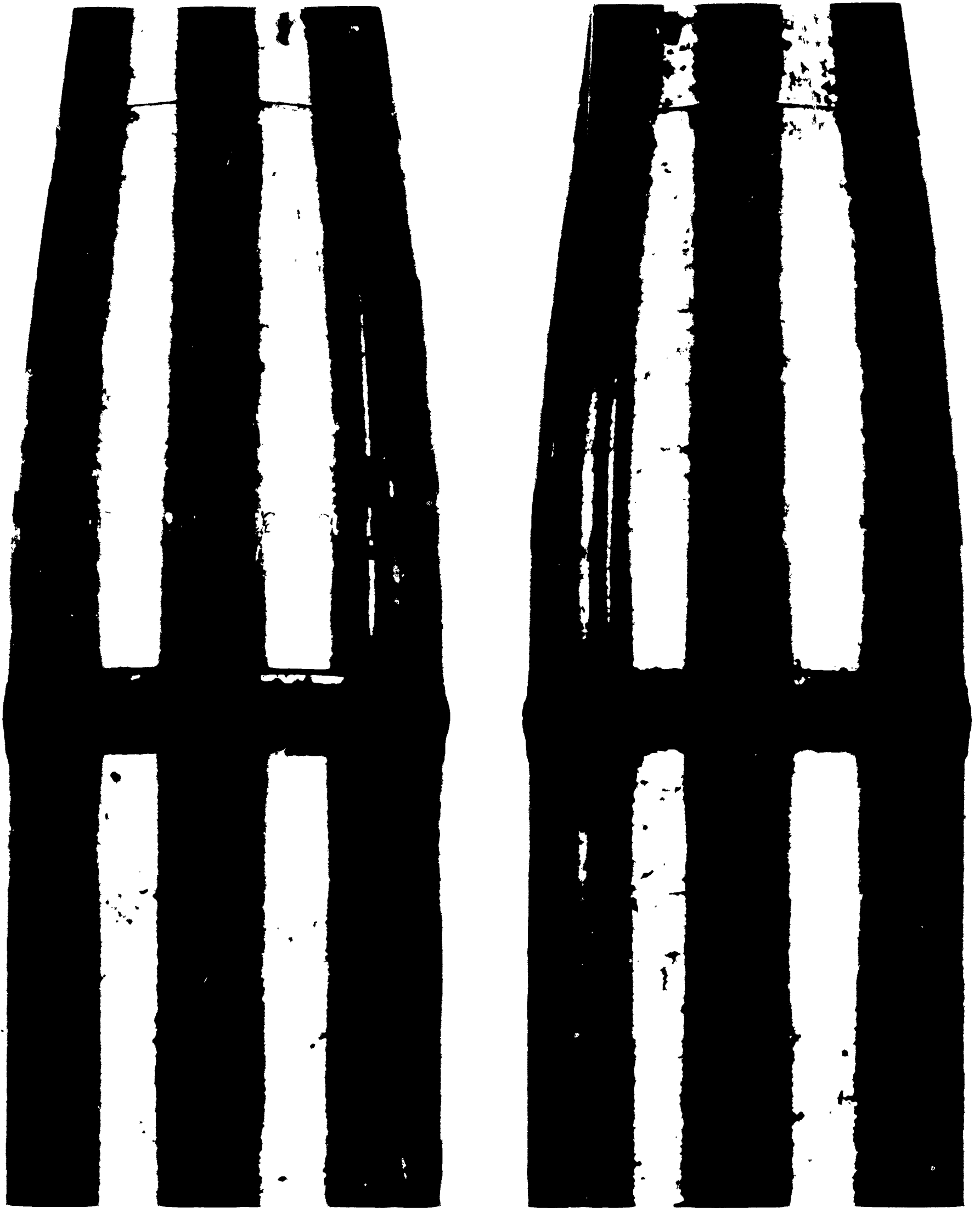
NP9-50923

15 March 1952

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Forward bands of projectiles after 3 days exposure to salt fog spray. Projectile on left has 3-3/64" holes drilled through band.

Figure 2



NP9-50924

22 March 1952

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Forward bands of projectiles after 7 days exposure to salt fog spray. Projectile on left had 3-3/64" holes drilled in band.

Figure 3



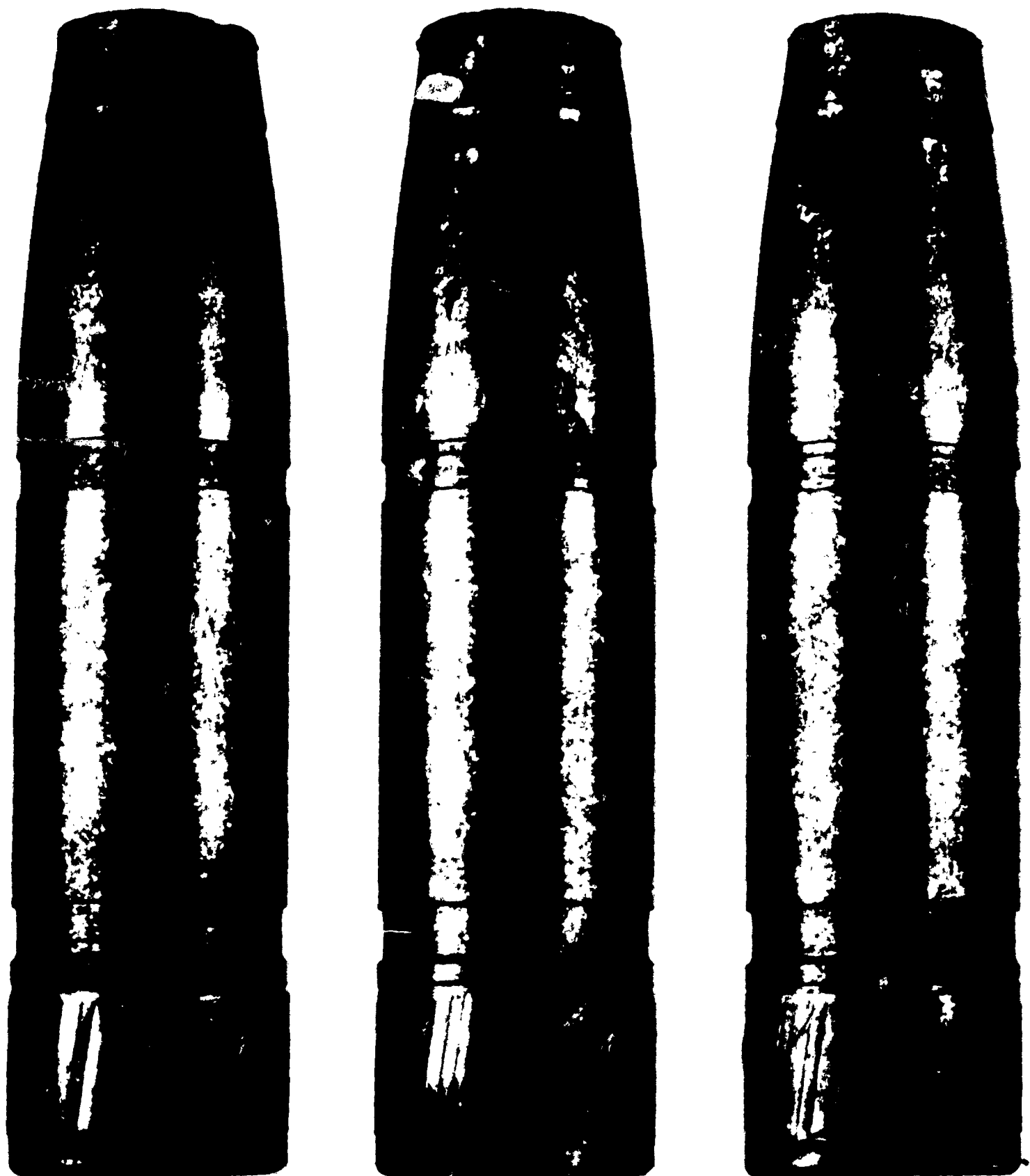
NP9-50925

3 April 1952

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Projectiles with forward bands removed after 7 days exposure to salt fog spray.

Figure 4



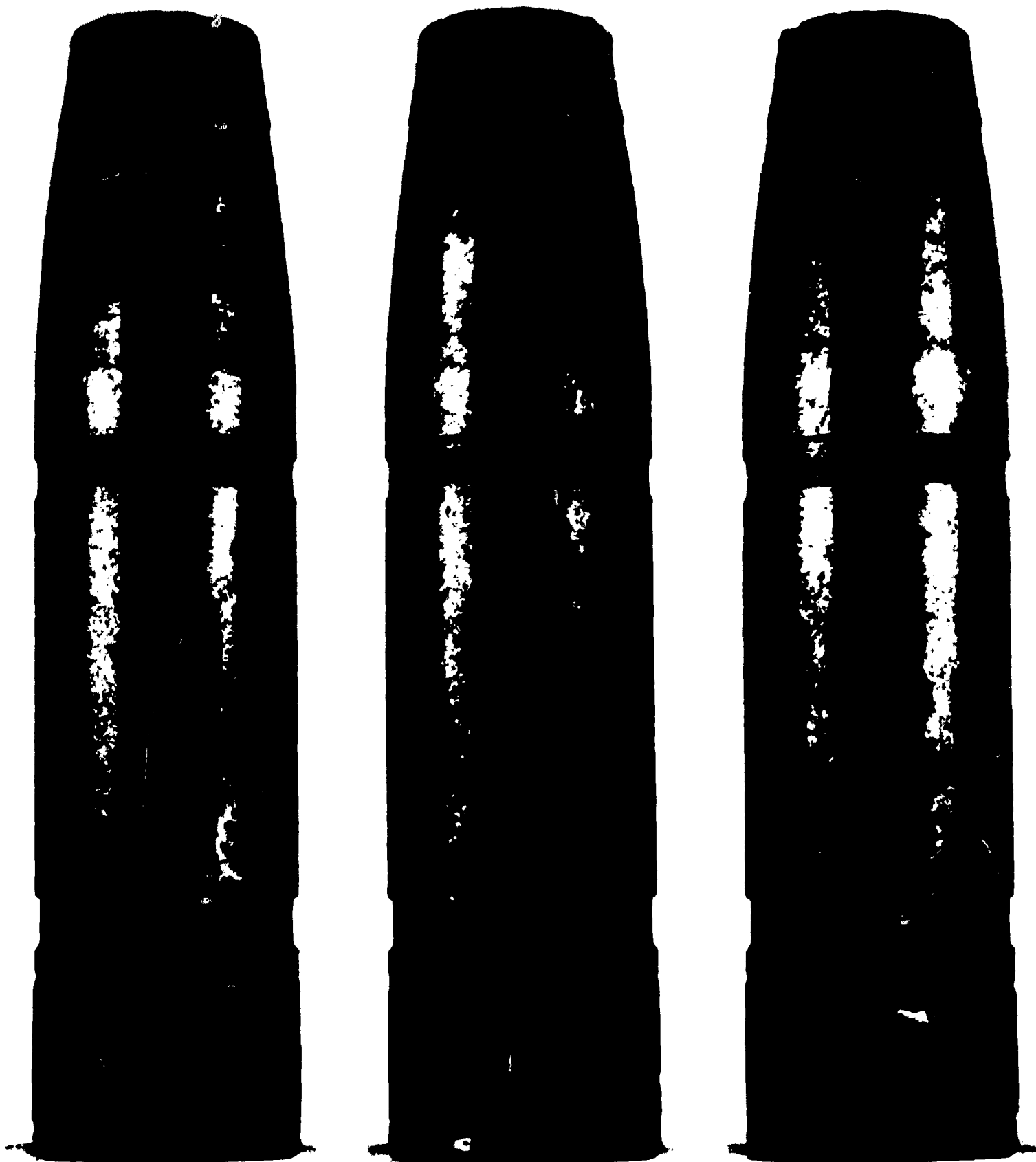
NP9-50926

18 April 1952

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Three views (120° apart) of recovered 3"/70 AA projectile Type
EX 24 Mod 9. Projectile No. 1224.

Figure 5



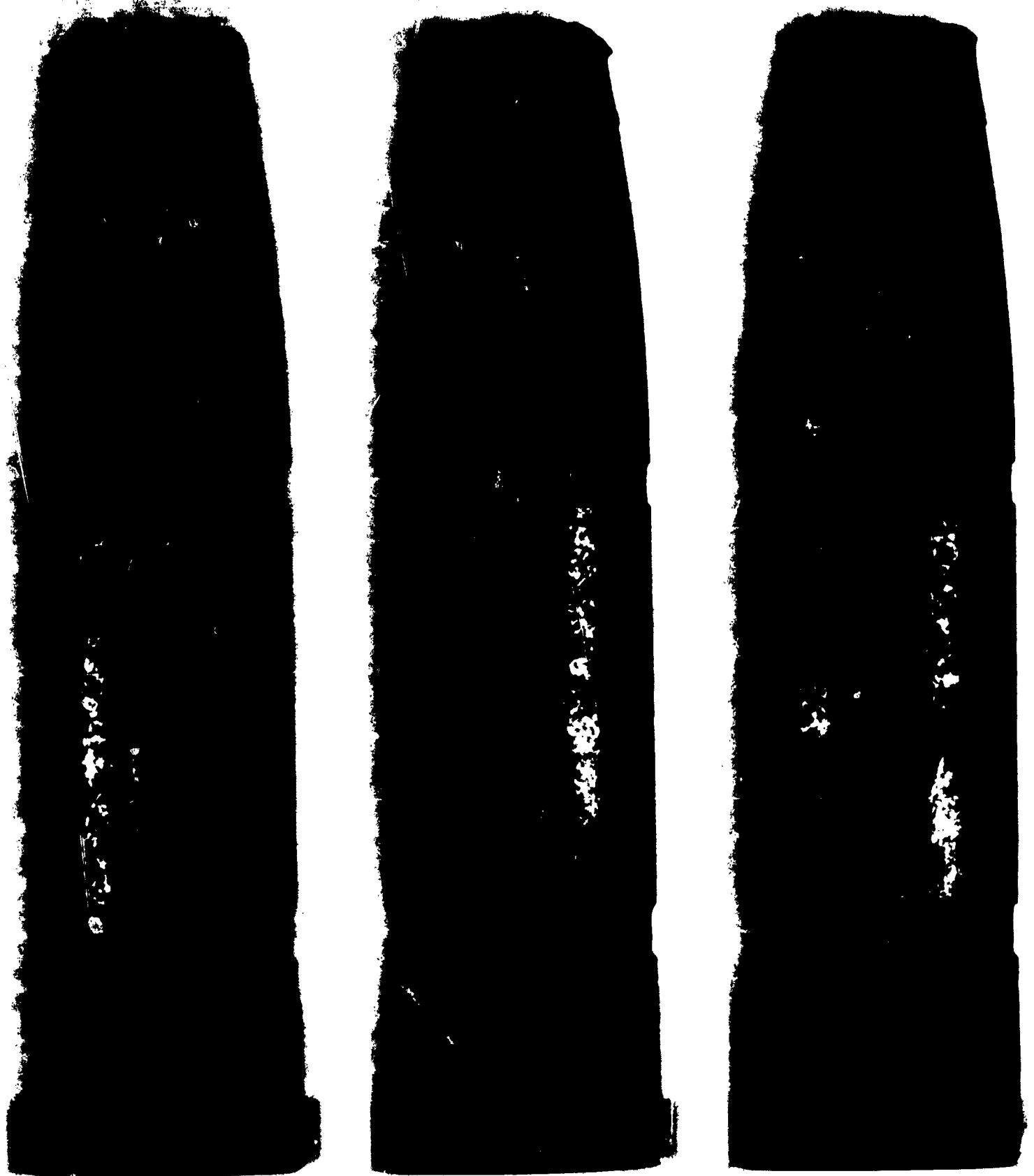
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18 April 1952

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Three views (120° apart) of recovered 3"/70 AA projectile Type
EX 24 Mod 9. Projectile No. 1225.

Figure 6



NP9-50928

18 April 1952

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Three views (120° apart) of recovered 3"/70 AA projectile Type
EX 24 Mod 9. Projectile No. 1226.

Figure 7



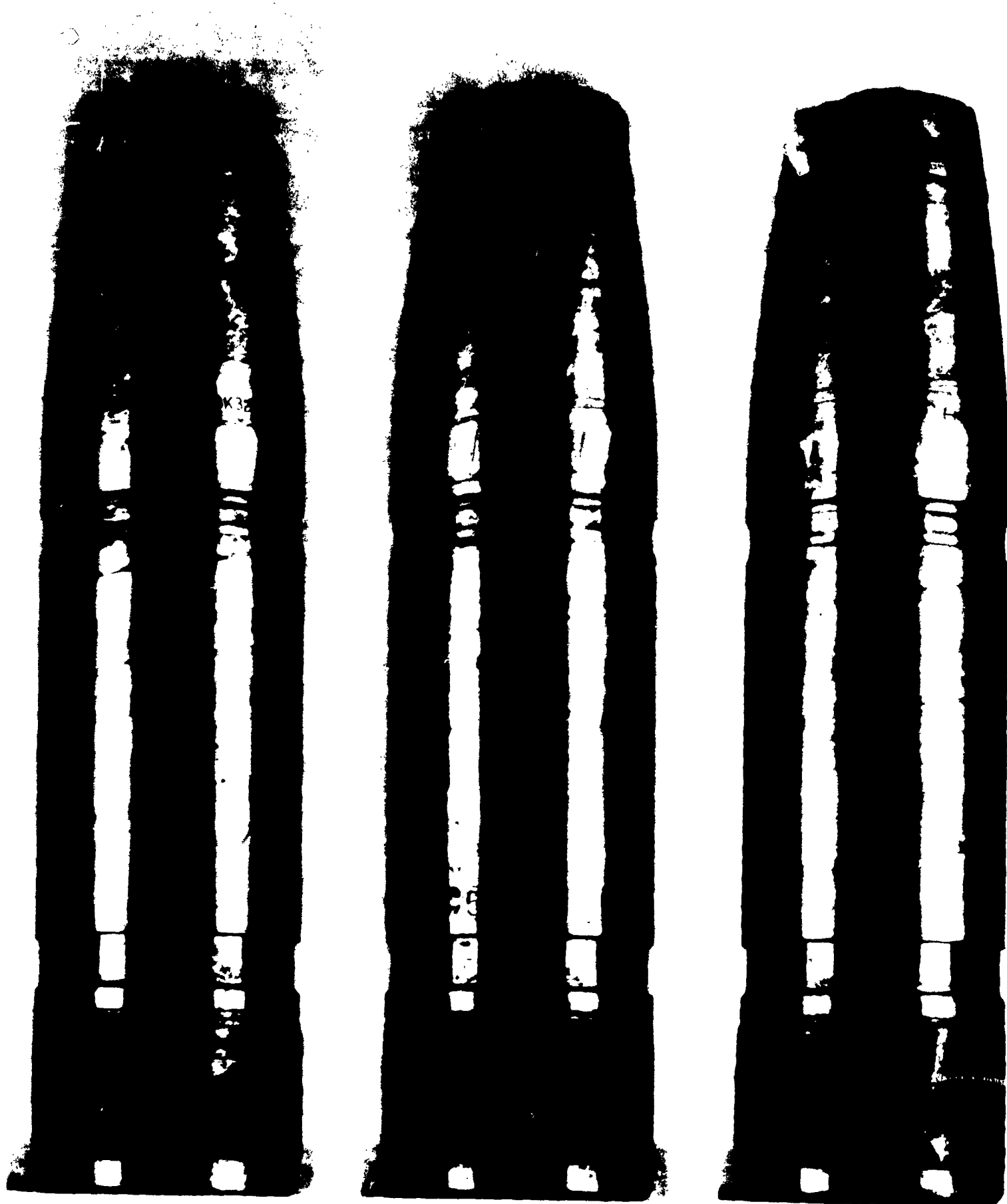
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18 April 1952

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Three views (120° apart) of recovered 3"/70 AA projectile Type
EX 24 Mod 9. Projectile No. 1227.

Figure 8



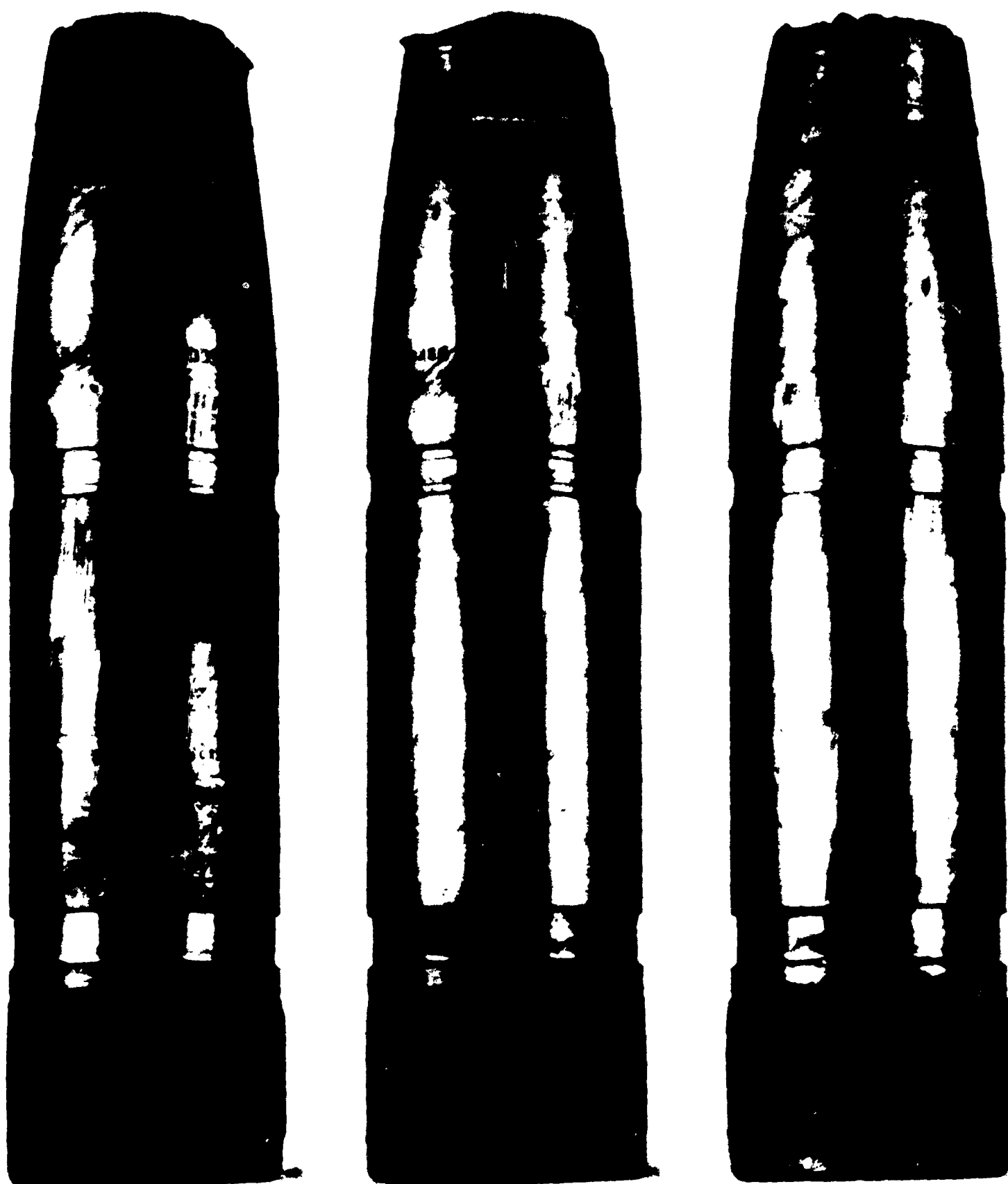
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18 April 1952

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Three views (120° apart) of recovered 3"/70 AA projectile Type
EX 24 Mod 9. Projectile No. 1228.

Figure 9



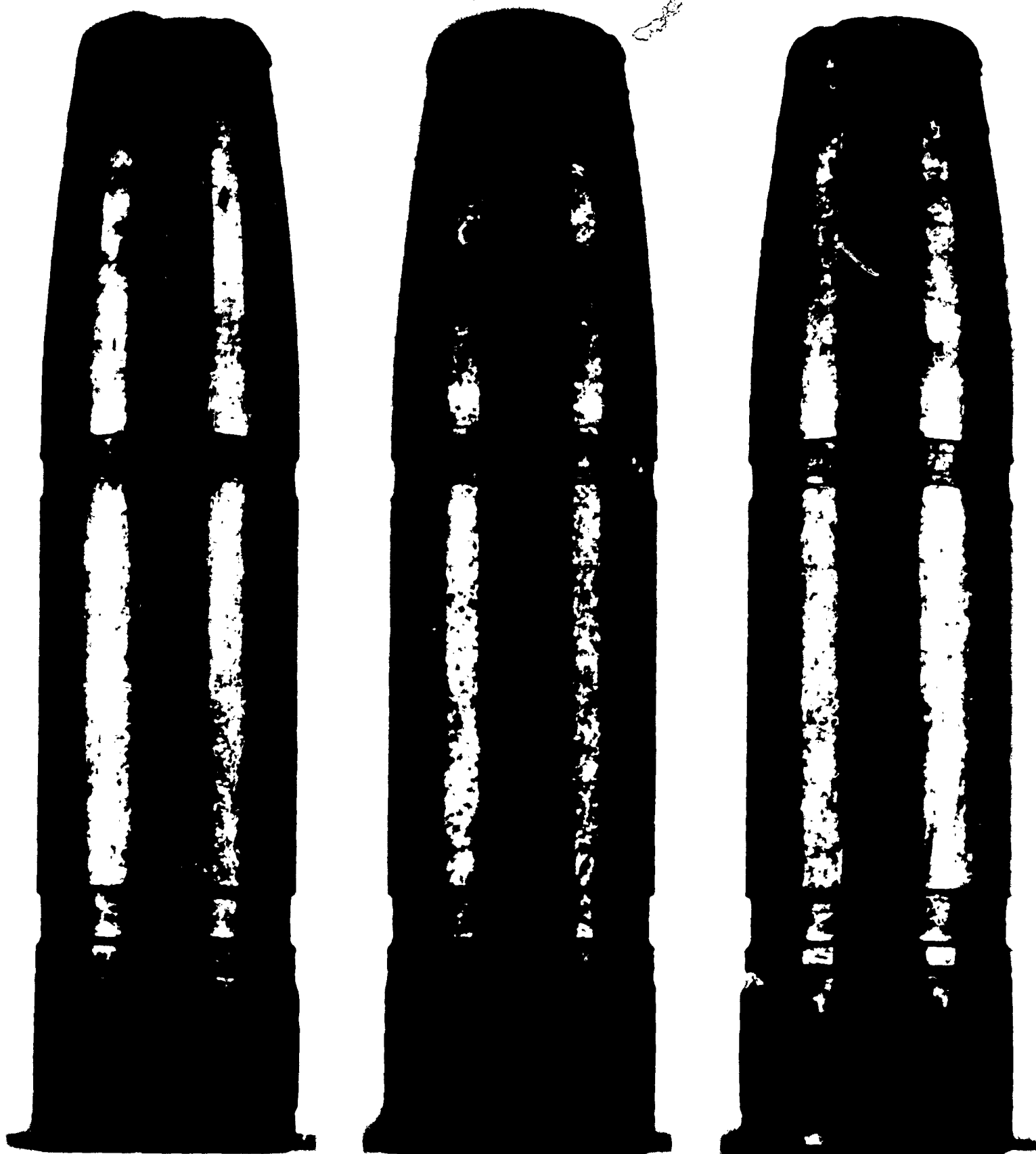
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18 April 1952

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Three views (120° apart) of recovered 3"/70 AA projectile Type
Ex 24 Mod 9. Projectile No. 1229.

Figure 10



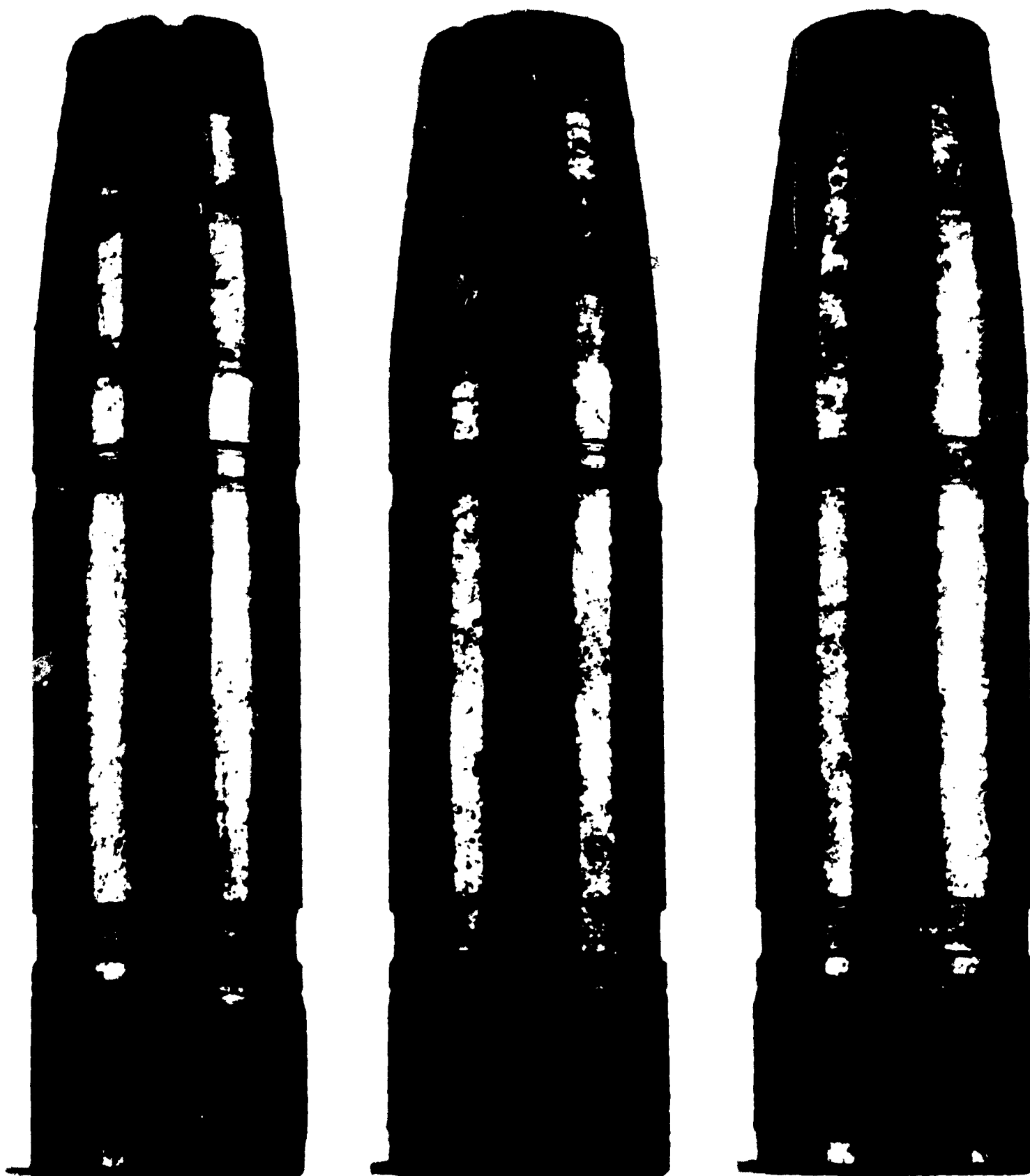
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18 April 1952

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Three views (120° apart) of recovered 3"/70 AA projectile Type
EX 24 Mod 9. Projectile No. 1230.

Figure 11



NP9-50933

18 April 1952

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Three views (120° apart) of recovered 3"/70 AA projectile Type
EX 24 Mod 9. Projectile No. 1231.

Figure 12

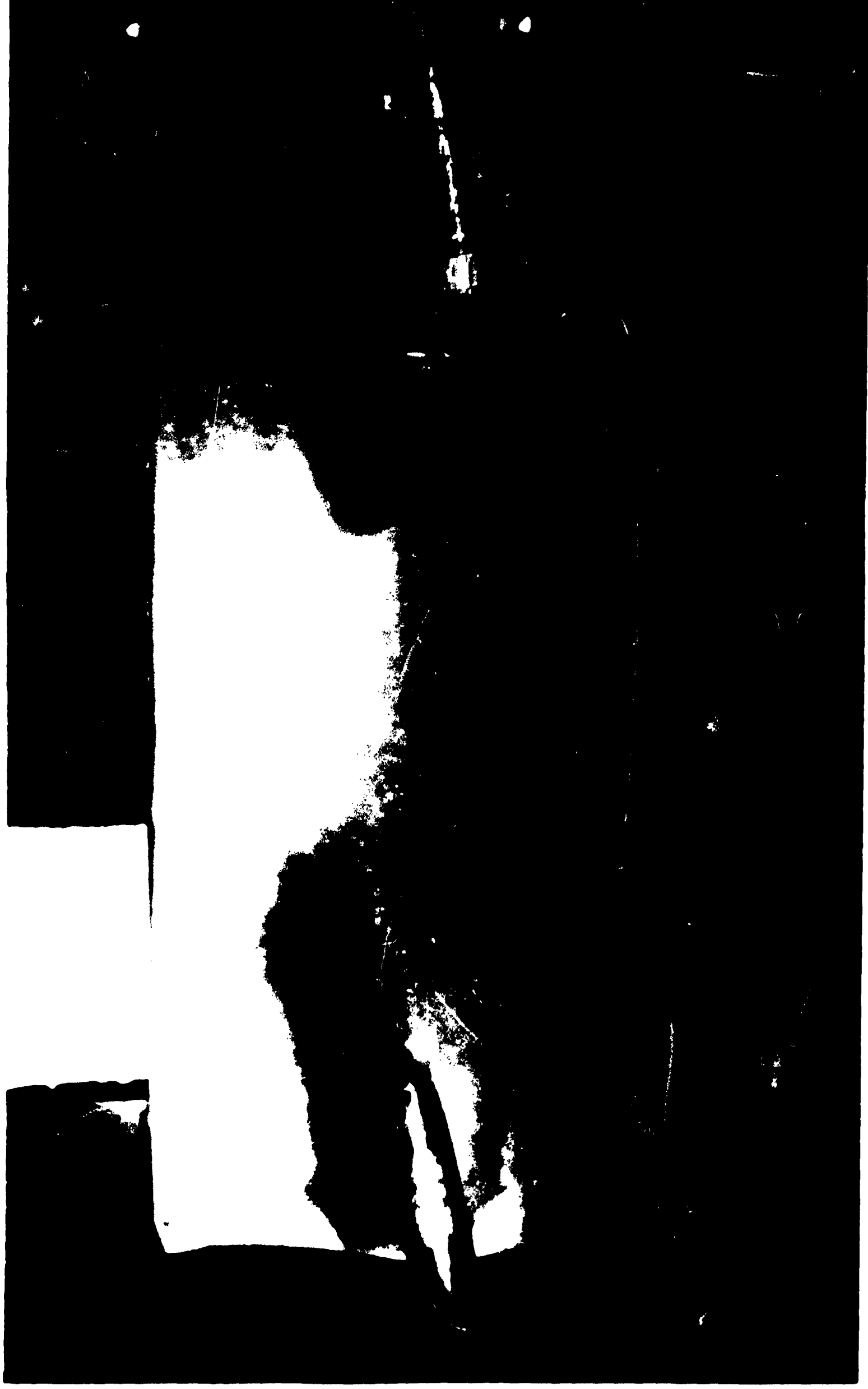
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18 April 1952

Microflash of 3"/70 AA Projectile Type EX 24 Mod 9 at 155 ft. from muzzle.
Projectile No. 1224.

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Figure 13



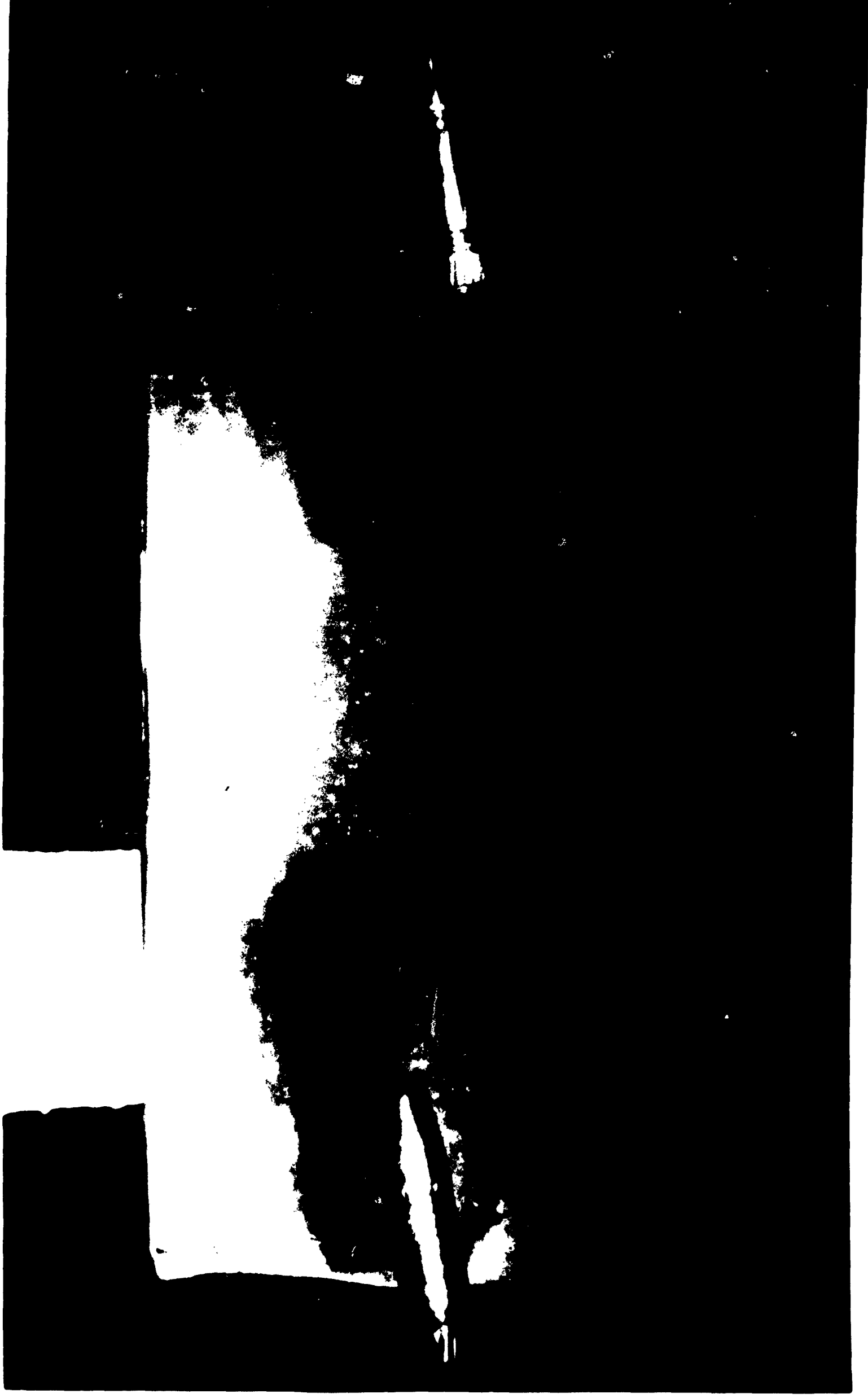
NY-90935

18 April 1957

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Microflash of 3"/70 projectile Type 33-24 Mod 9 at 155 ft. from muzzle.
Projectile No. 1.25.

Figure 14



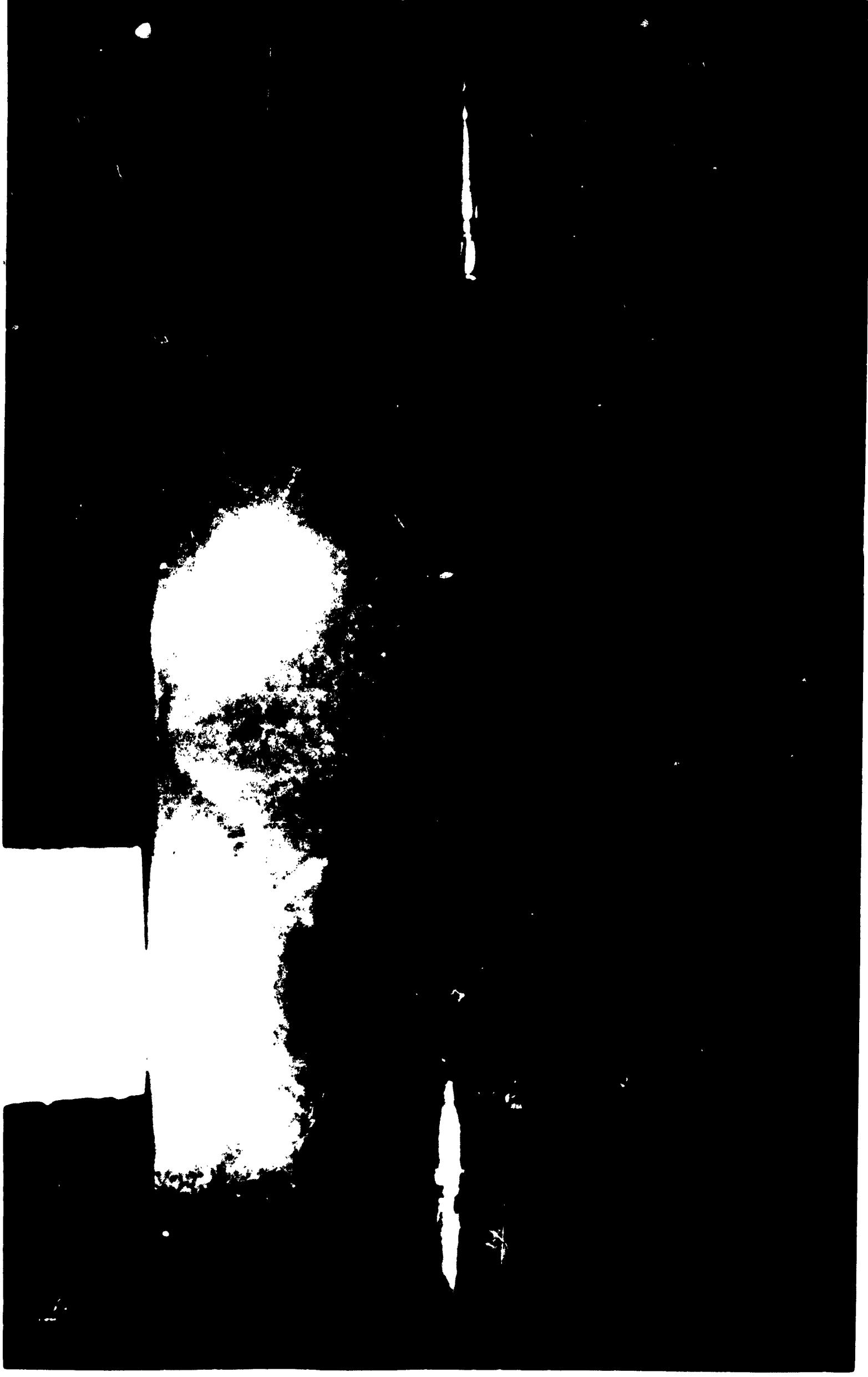
NP-50760

12 April 1952

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Microflash of 3"/70 mm projectile Type M4 Mod 9 at 155 ft. from muzzle.
Projectile No. 1279.

Figure 15



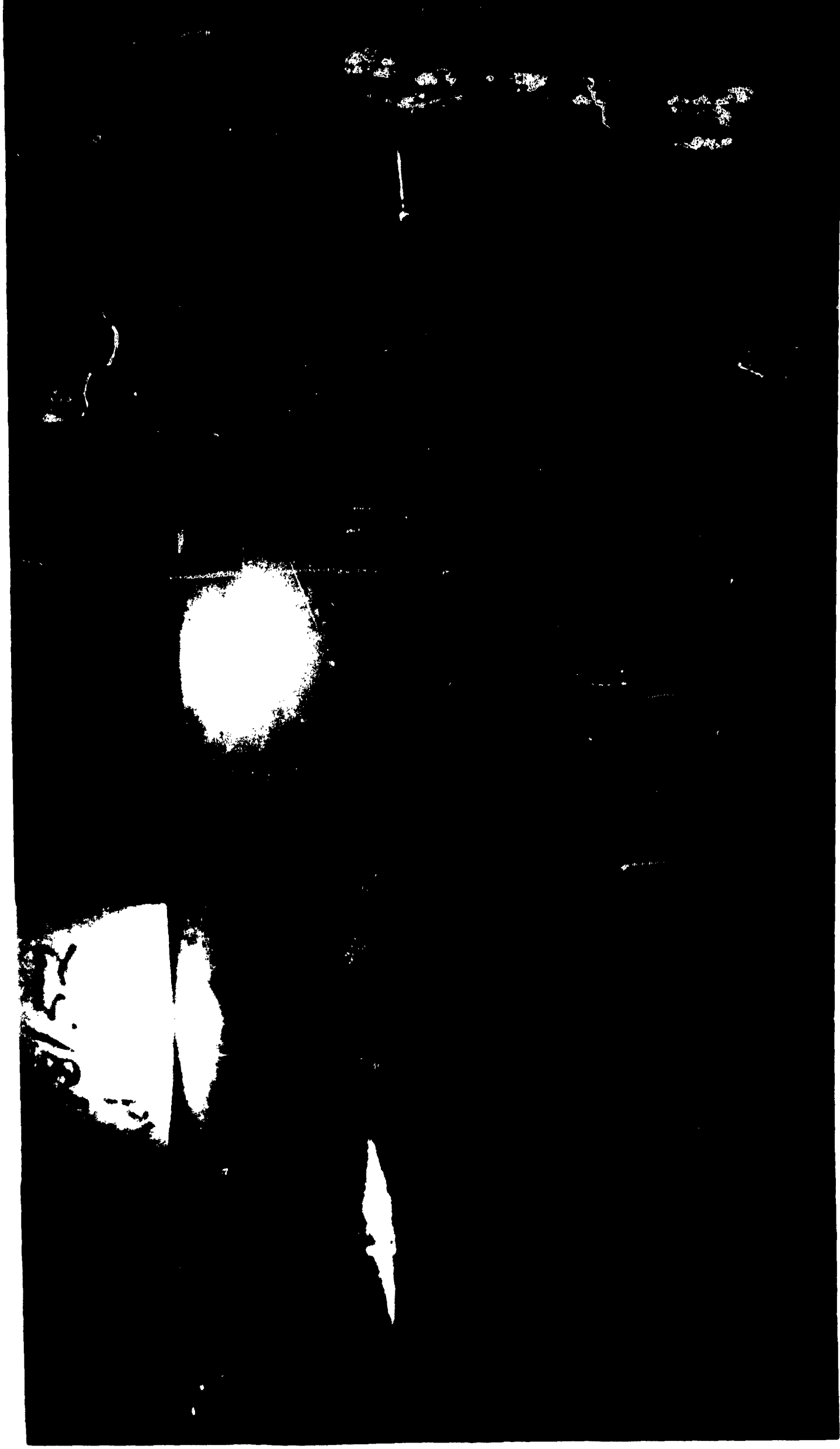
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18 April 1952

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Microflash of 3"/70 AA projectile Type EX 24 Mod 9 at 155 ft. from muzzle.
Projectile No. 1227.

Figure 16



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Test of 3"/70 AA Projectiles with Rusty Forward Band
Fired in Gun Type B Mod 5 No. 24480

Before



After

NP9-50938

26 March 1952

Photomicrographs of polished section of gun barrel before and
after abrasion test. Magnification 50X

Figure 17

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APPENDIX B

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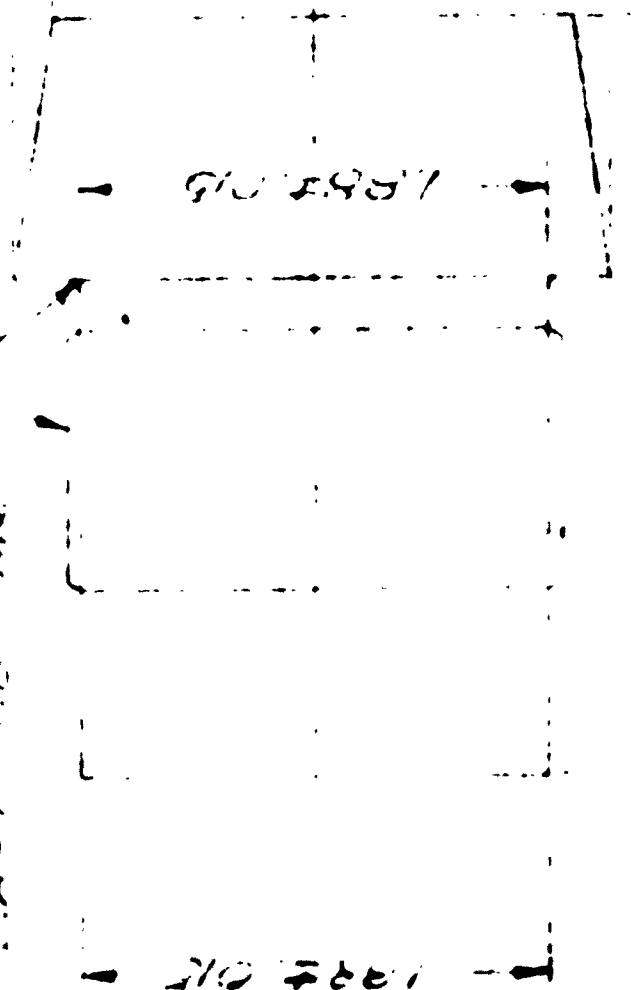
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FIGURE 18

2.00 ± 0.04
NOMINAL DIA = 2.00 ± 0.04
HATCH DIA = 2.00 ± 0.04
NOMINAL DIA = 2.00 ± 0.04

1.00 ± 0.04



1.00 ± 0.04 MAX.

1.00 ± 0.04

1.00 ± 0.04

DUMMY NOSE PLUG
(FIT AT NOSE)
MATERIAL: STEEL, FORGED
OR ROLLED STOCK

WEIGHT: 2.68 ± 0.05 LBS.

NOTE: BREAK SHARP EDGES

REF: SEE DUCORD SK 239269

APL-107
6812316
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Test of 3"/70 AA Projectiles with Rusty Forward Band
Fired in Gun Type B Mod 5 No. 24480

TABLE II

STAR GAUGE DATA

3"/70 Cal. Gun Type B Mod 5 No. 24480

All measurements taken from MUZZLE Face Gun Cold

Lands								
Dist.	X	Y	Dist.	X	Y	Dist.	X	Y
184.71	.391	.391	160	.003	.004	20	.039	.027
184.21	.388	.389	158	.004	.003	18	.037	.028
183.71	.386	.387	156	.004	.003	16	.033	.032
183.21	.354	.354	154	.003	.004	14	.031	.034
182.71	.317	.317	152	.003	.004	12	.025	.036
182.21	.280	.281	150	.003	.004	10	.024	.037
181.71	.248	.254	145	.003	.004	9	.022	.033
181.21	.216	.231	140	.004	.004	8	.022	.032
180.71	.194	.210	135	.004	.006	7	.022	.031
180.21	.166	.188	130	.010	.007	6	.021	.029
179.71	.141	.158	125	.016	.013	5	.022	.028
179.21	.114	.132	120	.017	.020	4	.022	.026
178.71	.094	.117	115	.018	.023	3	.019	.024
178.21	.091	.123	110	.023	.024	2	.020	.023
177.71	.087	.123	105	.026	.027	1	.021	.020
177.21	.088	.123	100	.030	.028	M	.025	.021
176.71	.085	.118	95	.033	.032	E.S.R. 761.08 Date 9 April 1952 Small Diameter 37002 Distance 162721		
176.21	.064	.105	90	.033	.037			
175.71	.053	.082	85	.042	.038			
175.21	.057	.082	80	.042	.038			
174.71	.084	.084	75	.042	.037			
174.21	.087	.081	70	.041	.040			
173.21	.087	.077	65	.037	.041			
172.21	.068	.059	60	.038	.042			
171.21	.017	.036	55	.040	.037			
170.21	.015	.028	50	.041	.031			
169.21	.007	.009	45	.038	.037			
168.21	.027	.026	40	.031	.039			
167.21	.028	.033	35	.028	.041			
166.21	.017	.017	30	.032	.034			
165.21	.005	.005	28	.035	.030			
164.21	.004	.004	26	.037	.026			
163.21	.003	.004	24	.040	.026			
162.21	.002	.003	22	.041	.027			

Test of 3"/70 AA Projectiles with Rusty Forward Band
Fired in Gun Type B Mod 5 No. 24480

TABLE II (Continued)

Grooves					
Dist.	Reading	Dist.	Reading	Dist.	Reading
184.71	37390	165.21	37089	45	37046
184.21	.388	164.21	.088	40	.043
183.71	.387	163.21	.087	35	.044
183.21	.358	162.21	.086	30	.045
182.71	.318	160	.085	28	.043
182.21	.287	158	.082	26	.042
181.71	.261	156	.081	24	.042
181.21	.217	154	.078	22	.037
180.71	.208	152	.078	20	.034
180.21	.189	150	.078	18	.031
179.71	.150	145	.077	16	.030
179.21	.113	140	.073	14	.031
178.71	.192	135	.071	12	.031
178.21	.191	130	.070	10	.032
177.71	.117	125	.064	9	.030
177.21	.119	120	.061	8	.031
176.71	.128	115	.057	7	.029
176.21	.121	110	.055	6	.028
175.71	.122	105	.051	5	.030
175.21	.114	100	.048	4	.028
174.71	.121	95	.046	3	.028
O. of 174.21	.122	90	.045	2	.028
B 173.21	.123	85	.046	1	.028
1" fwd. 172.21	.111	80	.043	M	.029
171.21	.107	75	.043		
170.21	.111	70	.052	E.S.R.	761.08
169.21	.106	65	.053	Date	9 April 1952
168.21	.102	60	.052		
167.21	.097	55	.050		
166.21	.093	50	.047		

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Test of 3"/70 AA Projectiles with Rusty Forward Band
Fired in Gun Type B Mod 5 No. 24480

TABLE III

STAR GAUGE DATA

3"/70 Cal. Gun Type B Mod 5 No. 24480

All measurements taken from MUZZLE Face Gun Cold

Lands			Origin of Bore 174.21					
Dist.	Reading		Dist.	Reading		Dist.	Reading	
184.71	37390	.390	160	.003	.002-1/2	20	.037	.032
184.21	.388	.388	158	.003	.003	18	.036	.033
183.71	.387	.388	156	.003	.003	16	.032	.037
183.21	.357	.356	154	.003	.002	14	.028	.040
182.71	.317	.317	152	.003	.003	12	.024	.038
182.21	.288	.283	150	.003	.003	10	.023	.037
181.71	.248	.251	145	.003	.004	9	.022	.034
181.21	.214	.227	140	.004	.004	8	.022	.032
180.71	.196	.205	135	.005	.006	7	.022	.031
180.21	.170	.185	130	.010	.010	6	.022	.025
179.71	.143	.150	125	.016	.014	5	.022	.025
179.21	.117	.122	120	.017	.018	4	.021	.023
178.71	.095	.094	115	.020	.022	3	.019	.021
178.21	.092	.091	110	.025	.022	2	.019	.019
177.71	.101	.108	105	.027	.026	1	.020	.018
177.21	.092	.113	100	.030	.028	Muzzle	.023	.019
176.71	.087	.100	95	.032	.034			
176.21	.071	.092	90	.033	.038			
175.71	.085	.080	85	.034	.038			
175.21	.084	.073	80	.043	.038			
174.71	.085	.068	75	.044	.041			
O.B. 174.21	.088	.081	70	.042	.044			
173.21	.088	.078	65	.036	.043			
172.21	.068	.045	60	.038	.041			
171.21	.028	.030	55	.041	.036			
170.21	.024	.028	50	.040	.038			
169.21	.010	.008	45	.038	.041			
168.21	.030	.018	40	.031	.043			
167.21	.037	.021	35	.028	.037			
166.21	.021	.011	30	.033	.030			
165.21	.007	.003	28	.034	.027	Eq. Ser. Rounds 769.08 Date April 23, 1952 Small Diameter 37002 Distance 163721		
164.21	.005	.003	26	.037	.027			
163.21	.003	.003	24	.038	.028			
162.21	.003	.003	22	.039	.030			

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Test of 3"/70 AA Projectiles with Rusty Forward Band
Fired in Gun Type B Mod 5 No. 24480

TABLE III (Continued)

Grooves					
Dist.	Reading	Dist.	Reading	Dist.	Reading
184.71	37389	160	.083	20	.042
184.21	.388	158	.082	18	.042
183.71	.388	156	.080	16	.043
183.21	.360	154	.080	14	.044
182.71	.317	152	.078	12	.041
182.21	.291	150	.078	10	.040
181.71	.263	145	.077	9	.038
181.21	.233	140	.073	8	.037
180.71	.228	135	.070	7	.034
180.21	.217	130	.068	6	.030
179.71	.180	125	.064	5	.026
179.21	.163	120	.062	4	.024
178.71	.153	115	.052	3	.023
178.21	.185	110	.055	2	.021
177.71	.216	105	.048	1	.022
177.21	.208	100	.050	Muzzle	.022
176.71	.182	95	.048		
176.21	.158	90	.048		
175.71	.144	85	.050		
175.21	.142	80	.058		
174.71	.141	75	.058		
O.B. 174.21	.140	70	.058		
173.21	.138	65	.053		
172.21	.111	60	.050		
171.21	.106	55	.045		
170.21	.111	50	.042		
169.21	.118	45	.041		
168.21	.107	40	.043		
167.21	.098	35	.041		
166.21	.092	30	.038		
165.21	.088	28	.046		
164.21	.078	26	.046		
163.21	.086	24	.047		
162.21	.086	22	.046		

Eq. Ser. Rounds 769.08
Date April 23, 1952

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